An analysis of carotid artery stenting procedures performed in New York and Florida (2005-2006): Procedure indication, stroke rate, and mortality rate are equivalent for vascular surgeons and non-vascular surgeons

Robert Steppacher, MD, Nicholas Csikesz, BS, Mohammad Eslami, MD, Elias Arous, MD, Louis Messina, MD, and **Andres Schanzer, MD,** *Worcester, Mass*

Objective: **Carotid artery stenting (CAS) has emerged as an alternative to carotid endarterectomy (CEA) for the treatment of carotid artery stenosis. Unlike CEA, CAS is performed by a wide variety of specialists including vascular surgeons (VS), interventional cardiologists (IC), and interventional radiologists (IR). This study compares the indications, in-patient mortality rate, and in-patient stroke rate for patients undergoing CAS, according to operator specialty.**

Methods: **The State In-patient Databases from New York and Florida, made available by the Healthcare Cost and Utilization Project, were reviewed by International Classification of Disease (ICD)-9-CM codes to identify all patients treated with CAS for the years 2005 and 2006. This cohort was then stratified according to operator specialty defined by procedures performed by each operator over the years surveyed. Primary endpoints were in-patient death and stroke. Propensity score matching adjusting for indication, demographics, and comorbidities was employed to evaluate the influence of operator type on outcomes.**

Results: **During the study period, 4001 CAS procedures were performed. All primary analyses compared VS (n = 1350) to non-VS (n = 2651). Patient characteristics were similar, except VS treated fewer patients with CAD (44.2% vs 50.9%, $P < .001$) and valvular disease (6.3% vs 8.6%, $P = .01$) and more patients with chronic lung disease (19.4% vs 15.9%, $P = .01$). Each group performed an equal proportion of CAS for symptomatic disease (8.1% vs 9.0%, $P = .32$). Univariate analysis revealed no difference in mortality (0.9% vs 0.5%, $P = .13$) or stroke (1.3% vs 1.5%, $P = .73$). Propensity score matched analysis also demonstrated no difference in mortality (0.7% vs 0.4%, $P = .48$) or stroke (1.1% vs 1.7%, $P = .27$). Subgroup analysis comparing VS, IC, and IR showed no significant difference in mortality or stroke, but demonstrated that of the three specialties, IC treated the smallest proportion of symptomatic patients. The proportion of CAS performed by VS differed significantly by state (New York 46%, Florida 19%, $P < .01$).**

Conclusion: **Despite a paucity of level 1 evidence for CAS in asymptomatic patients and current Centers for Medicare and Medicaid Services (CMS) policy limiting reimbursement for CAS to only high-risk symptomatic patients, VS and non-VS are treating primarily asymptomatic patients. Perioperative rates of stroke and death are equivalent between VS, IC, and IR. Regional variation of operator type is substantial, and despite similar outcomes, <50% of CAS is performed by VS.**
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Since its inception in the early 1990s, carotid artery stenting (CAS) has emerged as an alternative to carotid endarterectomy (CEA) for the treatment of carotid artery occlusive disease. Numerous single institution studies,[1] stent registry reports,[2,3] administrative dataset evaluations,[4-6] and randomized controlled trials,[7-9] have assessed the safety and efficacy of CAS for the treatment of both symptomatic and asymptomatic carotid artery disease.[10] Because the results of these studies have been mixed, CEA, founded on a history of rigorous evidence-based validation,[11,12] has persisted as the standard of care. Nonetheless, CAS use has continued to increase dramatically.[3]

In contrast to CEA, which has been performed uniformly by surgeons (primarily those trained specifically in vascular surgery), CAS has been embraced by multiple specialty groups that possess catheter and guidewire skills. Accordingly, professional societies of vascular surgeons,[13] cardiologists,[14] and interventional radiologists[15] have issued consensus statements regarding the indications for use of this technology and credentialing requirements for providers performing CAS. Despite the increasing rate of CAS procedures being performed by these different operators, the current role of CAS remains undefined. This sentiment was reinforced by the Centers for Medicare and Medicaid's recent decision to deny reimbursement for CAS in any

From the Division of Vascular and Endovascular Surgery, University of Massachusetts Medical School.
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Reprint requests: Andres Schanzer, MD, Division of Vascular and Endovascular Surgery, University of Massachusetts Memorial Medical Center, 55 Lake Avenue North, Worcester, MA 01655 (e-mail: schanzea@ummhc.org).
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Table 1. Procedure codes used to categorize operator types

Vascular surgeon	*Interventional cardiologist*
38.12 – Carotid endarterectomy (open)	00.66 – PTCA
38.34 – Aortic resection with anastomosis	36.01 – Single vessel PTCA without mention of thrombolytic agent
38.44 – Aortic resection with replacement	36.02 – Single vessel PTCA with mention of thrombolytic agent
39.29 – Peripheral vascular shunt or bypass	36.05 – Multiple vessel PTCA
84.15 – Amputation – below the knee	36.06 – Insertion of non-drug-eluting coronary artery stent
84.17 – Amputation – above the knee	36.07 – Insertion of drug-eluting coronary artery stent
	37.21 – Right heart cardiac catheterization
	37.22 – Left heart cardiac catheterization
	37.23 – Combined right and left heart cardiac catheterization

PTCA, Percutaneous transluminal coronary angioplasty.

patients who are not symptomatic and who do not meet defined high risk criteria.[16]

The purpose of this large administrative dataset study is to evaluate in-patient mortality and stroke rates for patients undergoing CAS when stratified according to operator specialty (vascular surgeons [VS], interventional cardiologists [IC], and interventional radiologists [IR]). The secondary goal is to assess for differences in patient characteristics and procedural indications between the groups of patients treated by providers from each specialty.

METHODS

Data source. All patients who underwent CAS in the states of New York (NY) and Florida (FL) during the years 2005-2006 were identified by querying the State In-patient Databases for the procedure codes 00.63 (carotid artery stenting) and 00.61 (carotid artery angioplasty). These databases are both supported by the Healthcare Cost and Utilization Project and contain all patient discharge records from participating non-federal academic and private acute care hospitals. Participation in this program is nearly comprehensive with 218 of 235 eligible hospitals in FL and 206 of 208 eligible hospitals in NY participating in the years analyzed. The duration of the study was limited to the years 2005 and 2006 in order to take advantage of the most recent data available since the institution of unique International Classification of Disease (ICD)-9-CM codes (00.63 and 00.61) for carotid artery stenting and angioplasty. The states of NY and FL were chosen for analysis as the combined demographics of these two populous states are thought to be fairly representative of the United States as a whole.[17]

Data abstraction. The study cohort consisted of all patients identified by ICD-9-CM procedural codes 00.63 (carotid artery stenting) and 00.61 (carotid artery angioplasty). Demographic variables analyzed included age, gender, payer source, operator volume, resource utilization, and median income. Comorbidities analyzed included hypertension, complicated and uncomplicated diabetes, renal failure, valvular disease, congestive heart failure, chronic lung disease, morbid obesity, and coronary artery disease. The presence of these comorbidities were identified using the Elixhauser technique,[18] except for coronary artery disease which was assigned based on the presence of an ICD-9 code for angina pectoris, chronic ischemic heart disease, or cardiovascular disease, unspecified. Median income was determined based on the average census income of the zip code of the patient's residence.

Procedure characteristics evaluated included procedural indication (symptomatic vs asymptomatic) and admission type (elective vs non-elective). Symptom status was determined according to the method described by McPhee et al[5,19] Any patient with any ICD-9 code for transient ischemic attack, amaurosis fugax, or stroke at the time of admission was defined as symptomatic. Admission coding was used to determine elective vs non-elective admission.

Assignment of operator type and volume. The State In-patient Databases of NY and FL document a physician of record for each procedure performed. Each physician performing any procedure is assigned an anonymous numerical unique provider identifier (UPI). The UPI is preserved for every physician for each year of data collected, and preserved across all hospitals in each state.

The UPI was used to identify all procedures performed by a specific provider over a given year of the study. Each CAS practitioner's annual non-CAS procedure mix was used to categorize each operator into a given specialty: VS, IC, or IR. In order to circumvent potential procedural miscoding in the database, a protocol for the discrimination of operator specialty type was followed. For each UPI, a query was performed for ICD-9 codes corresponding to procedures commonly performed by VS and IC (Table I). Providers whose UPIs were linked exclusively to ICD-9 codes corresponding to common VS procedures were defined as VS; if linked exclusively to common IC procedures, providers were defined as IC. Any provider whose UPI was linked to no common VS or IC procedure was defined as IR.

Any provider whose UPI was linked to both VS and IC procedures was assigned as either VS or IC according to the proportion of VS vs IC codes recorded in the database (Fig). A threshold of 70% was used for segregation. If greater than 70% of total recorded procedures were VS procedures, the provider was assigned to VS; conversely, if greater than 70% of procedures were IC procedures, the provider was assigned to IC. All physicians were further categorized by number of CAS procedures recorded in the database during the study period. Volume categories were

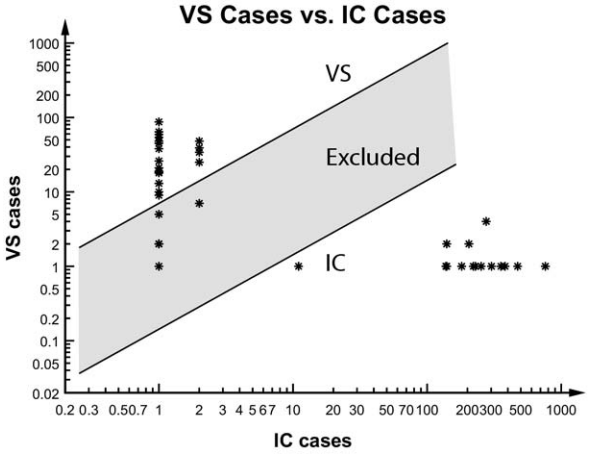

Fig. A graphical representation of the method used for the assignment of operator type. Any provider linked to both vascular surgeons (VS) and interventional cardiologist (IC) codes was defined as either VS or IC according to the proportion of VS procedures coded. A threshold of 70% was used for discrimination. If greater than 70% of total recorded procedures were VS procedures, the provider was assigned to VS; conversely, if greater than 70% of total recorded procedures were IC procedures, the provider was assigned to IC. Of 645 unique "Unique Provider Identifier" (UPIs), only four providers were unable to be classified (0.6%). For clarity, a logarithmic scale is used to display the data.

defined according to tertiles: low (<9 cases/year), medium (9-23 cases/year) and high (>23 cases/year).

Endpoints and statistical analysis. The primary endpoints for this study were in-patient death and stroke. Death was recorded in the database as a discharge variable. Stroke was defined in any patient with the ICD-9 code of 997.02 (postoperative stroke) at the time of discharge.[5]

Baseline characteristics and the incidence of death and stroke were compared between groups using Pearson's χ^2 analysis for categorical variables and t test for continuous variables. Comparisons relating to length of stay were made with the Wilcoxon Rank Sum tests for non-parametric data. Propensity score matching[20] was employed in order to adjust for different baseline demographic, comorbid, and procedural covariates. Utilizing this methodology to control for the aggregate amount of measured confounding, matched groups of patients undergoing CAS were compared. The covariates included in the propensity score analysis included age, gender, race, insurance type, income bracket, comorbidities (hypertension, diabetes, renal failure, valvular heart disease, congestive heart failure, chronic lung disease, obesity), admission type (elective vs non-elective), and indication (symptomatic vs asymptomatic).

All tests were considered statistically significant at an alpha level of 0.05 ($P = .05$, two-tailed). All analyses were performed using SAS version 9.1 (Cary, NC).

RESULTS

During the study period, 4063 CAS procedures were performed by 645 unique providers. Four providers (62 CAS cases, 1.5% of total) could not be classified according to the operator type assignment algorithm (described above) and were, therefore, excluded from all analyses. The remaining 4001 CAS procedures, performed by 641 operators, form the study cohort evaluated. Of these, providers identified as VS performed 1350 of these procedures (VS group). The remaining 2651 CAS procedures were performed by IC and IR providers (non-VS group). Of these, 1529 CAS procedures were performed by physicians identified as IC and 1122 by physicians identified as IR.

Patient characteristics (Table II) were similar between the VS and non-VS groups in terms of age, gender, presentation type, number of comorbidities, and type of comorbidities except VS treated fewer patients with CAD (44.2% vs 50.9%, $P < .01$) and valvular heart disease (6.3% vs 8.6%, $P = .01$) and more patients with chronic lung disease (19.4% vs 15.9%, $P = .01$). Payer source was similar between groups. The VS group treated fewer patients with income >$45,000 level (20.2% vs 29%, $P = .0005$). Each group performed an equal proportion of CAS procedures for symptomatic disease (8.1% vs 9.0%, $P = .32$). VS treated more patients with elective admissions (69.8% vs 66.4%, $P = .03$).

CAS procedure volume differed by specialty (Table III). In the VS group, nearly equal proportions of providers were classified as low- (33.3%), medium- (35.5%), and high- (31.2%) volume operators. In contrast, the largest proportion of IC providers were categorized as high-volume operators (47.1%), while the largest proportion of IR providers were categorized as low-volume operators (45.1%).

Primary endpoints: in-patient stroke and death. On univariate evaluation, no difference in either mortality (0.9% vs 0.5%, $P = .13$) or stroke (1.3% vs 1.5%, $P = .73$) between the VS and non-VS groups was observed (Table IV). No difference in stroke or mortality was seen between low (<9 cases/year), medium (9-23 cases/year), or high (>23 cases/year) volume operators (Table V).

Subgroup analysis by individual specialty was also performed. Direct comparison between the VS and IC groups and between the VS and IR groups failed to show any significant difference in the rate of stroke or mortality (Table VI*A*). In examining the subset of symptomatic patients, no difference was seen between the VS and IC groups and between the VS and IR groups (Table VI*B*).

After adjusting for potential confounding variables with the use of propensity score matching, no significant difference in either stroke or mortality was observed (Table VII). The mortality rate for patients treated by VS was 0.7% and by non-VS was 0.4% ($P = .48$); the stroke rate for patients treated by VS was 1.1% and by non-VS was 1.7% ($P = .27$).

Resource utilization analysis (Table VIII) demonstrated that the post procedural length of stay was similar

Table II. Characteristics associated with carotid artery stenting procedures analyzed according to operator specialty

	Total (n = 4001)	*Vascular surgeon (n = 1350)*	*Non-vascular surgeon (n = 2651)*	P *value*
Carotid stents performed n (%)	100%	33.7%	66.3%	
Patient characteristics				
Mean age, years (median)	71.1	70.9 (72)	71.2 (72)	.27
Age ≥80 years	20.8%	20.7%	20.9%	.84
Male (%)	62.0%	61.1%	62.5%	.39
Race (%)				
White	80.4%	83.3%	79.0%	.001
African American	3.3%	2.9%	3.5%	.33
Hispanic	7.0%	5.9%	7.5%	0.52
Other	9.4%	8.0%	10.0%	.037
Specific comorbidities:				
Hypertension	75.8%	74.7%	76.3%	.28
Diabetes mellitus				
Uncomplicated	27.9%	27.3%	28.3%	.49
Chronic complications	2.5%	2.0%	2.7%	.17
Renal failure	6.2%	5.5%	6.6%	.18
CAD/MI	48.6%	44.2%	50.9%	<.0001
Valvular disease	7.9%	6.3%	8.6%	.01
CHF	8.8%	8.2%	9.1%	.30
Chronic lung disease	17.2%	19.4%	15.9%	.25
Obesity	3.3%	3.8%	3.1%	.25
Number of comorbidities				
0	9.4%	9.3%	9.4%	.86
1	30.2%	30.0%	30.0%	.83
2	29.9%	30.1%	29.8%	.88
≥3	30.5%	30.7%	30.4%	.86
Median income by zip code (%)				
$1-$24,999	24.4%	24.2%	24.5%	.84
$25,000-$34,999	28.4%	30.3%	27.3%	.14
$35,000-$44,999	22.6%	25.3%	21.1%	.025
>$45,000	24.6%	20.2%	27.0%	.005
Insurance type (%)				
Private/Medicare	93.5%	93.5%	93.5%	.99
Medicaid/self pay	4.9%	4.7%	5.0%	.66
Presentation type				
Asymptomatic (%)	91.3%	91.9%	91%	.32
Symptomatic (%)	8.7%	8.1%	9.0	.32
TIA (%)	2.6%	2.2%	2.8%	.22
Amaurosis fugax (%)	1.2%	1.1%	1.2%	.63
Stroke (%)	5.2%	5.0%	5.3%	.87
Admission type				
Non-elective	32.4%	30.2%	33.6%	.03
Elective	67.6%	69.8%	66.4%	.03

CAD, Coronary artery disease; *MI,* myocardial infarction; *CHF,* congestive heart failure; *TIA,* transient ischemic attack.

Table III. Operator type stratified by procedure volume (TERTILES)

	Low volume (<9/years)	*Medium volume (9-23/years)*	*High volume (>23/years)*
Total	34.9%	32.1%	33.0%
VS	33.3%	35.5%	31.2%
IC	28.8%	24.1%	47.1%
IR	45.1%	39.0%	16.0%

VS, Vascular surgeons; *IC,* interventional cardiologists; *IR,* interventional radiologists.

Table IV. In hospital stroke and mortality comparison between VS and non-VS

	Total (n = 4001)	*Vascular surgeon (n = 1350)*	*Non-vascular surgeon (n = 2651)*	P *value*
Stroke (%)	1.4%	1.3%	1.5%	.73
Mortality (%)	0.6%	0.9%	0.5%	.13

between the groups (VS 2.8 days vs non-VS 3 days, $P = .13$). The VS group had significantly lower total hospital charges than the non-VS group ($34,800 vs $40,600, $P < .0001$).

In order to assess regional variation in practice patterns, the frequency with which CAS procedures were performed by VS and non-VS was compared between the states of NY and FL. In NY, a significantly greater proportion of CAS procedures were performed by VS than in FL (45.7% vs 18.9%, $P < .0001$) (Table IX). Of non-VS operators, IC

Table V. In hospital stroke and mortality comparison between VS and non-VS stratified by procedure volume (TERTILES)

	Low volume (<9/years)		*Medium volume (9-23/years)*		*High volume (>23/years)*	
	Non-VS n = 947	*VS n = 450*	*Non-VS n = 805*	*VS n = 479*	*Non-VS n = 899*	*VS n = 421*
Stroke (%)	1.8%	1.3% *P* = .52	1.6%	1.7% *P* = .94	1.0%	1.0% *P* = .93
Mortality (%)	0.8%	0.7% *P* = .72	0.3%	1.0% *P* = .06	0.3%	1.0% *P* = .15

VS, Vascular surgeon; *N,* number.

Table VI A. In hospital stroke and mortality subgroup analysis according to specialty

	Total (n = 4001)	*Vascular surgeon (n = 1350)*	*Cardiologist (n = 1529)*	*Interventional radiologist (n = 1122)*	P *value (VS vs IC)*	P *value (VS vs IR)*
Stroke (%)	1.4%	1.3%	1.1%	2.0%	.59	.22
Mortality (%)	0.6%	0.9%	0.5%	0.5%	.24	.18

VS, Vascular surgeon; *IC,* interventional cardiologists; *IR,* interventional radiologists.

Table VI B. In hospital stroke and mortality subgroup analysis according to specialty in symptomatic patients

	Total (n = 348)	*Vascular surgeon (n = 109)*	*Cardiologist (n = 88)*	*Interventional radiologist (n = 151)*	P *value (VS vs IC)*	P *value (VS vs IR)*
Stroke (%)	3.5%	2.8%	3.4%	4.0%	.79	.60
Mortality (%)	4.3%	6.5%	4.6%	2.7%	.57	.14

VS, Vascular surgeons; *IC,* interventional cardiologists; *IR,* interventional radiologists.

Table VII. In hospital stroke and mortality after propensity score matching for age, gender, race, primary insurance, income bracket, comorbidities (hypertension, uncomplicated diabetes, complicated diabetes, renal failure, valvular disease, CHF, chronic lung disease, obesity), admission type, and symptom status (symptomatic vs asymptomatic)

	Propensity score matched cohort		
	Vascular surgeon (n = 761)	*Non-vascular surgeon (n = 761)*	P *value*
Stroke (%)	1.1%	1.7%	.27
Mortality (%)	0.7%	0.4%	.48

performed an equal proportion of CAS procedures in each state (37.5% vs 39.1% *P* = .288), but a greater proportion of CAS procedures was performed by IR in FL than in NY (42% vs 16.8%, *P* < .0001).

DISCUSSION

This study demonstrates that CAS is being performed by multiple specialty groups with equivalent in-hospital stroke and mortality rates observed between VS and non-VS operators. This finding, documented on univariate analysis, was also confirmed using a propensity score matched analysis to control for multiple confounders. Furthermore, on stratified analysis, mortality and stroke rates were not associated with operator CAS volume and remained equivalent when the VS group was compared individually to the IC and IR groups. The other salient finding in this study is the overwhelming number of asymptomatic patients treated with CAS (91% of total cohort) by all operator types.

The rates of in-hospital stroke (1.4%) and mortality (0.6%) documented in this study is lower than the rate reported in a recent clinical trial[7] and the Society for Vascular Surgery (SVS) registry.[21] However these rates are comparable to those reported by others using similar administrative data[5,19,22] and to a recently published large meta-analysis.[4] Because this study was not specifically designed to compare the results of CAS with CEA, we do not feel it is possible, or appropriate, to make any comments that would suggest either superiority or inferiority of CAS over CEA. Furthermore, independent neurologic evaluation was not uniformly utilized in determining the stroke rate in this administrative dataset. Thus, the stroke rate reported here cannot and should not be compared to those reported in prospectively conducted clinical trials.

Medicare has instituted strict guidelines for the reimbursement for CAS.[16] Currently, under these rules, CAS is reimbursed by Centers for Medicare and Medicaid Services (CMS) only in the setting of symptomatic patients who are deemed "high risk" for CEA according to specific physiologic or anatomic parameters. Despite these restrictions, the majority of patients in the current study were treated

Table VIII. Resource utilization after CAS

	Total (n = 4001)	*Vascular surgeon (n = 1350)*	*Non-vascular surgeon (n = 2651)*	P *value*
Mean LOS (SD)	3.0 ± 4.7	2.8 ± 4.2	3.0 ± 4.9	.13
Median LOS (range)	1 (0-85)	1 (0-59)	1 (0-85)	.13
Disposition	85.5%	84.5%	86.0%	.21
Home (%)	6.9%	7.8%	6.4%	.10
Rehab (%)	0.6%	0.9%	0.5%	.13
Died (%)	7.0%	6.8%	7.1%	.71
Other (%)				
Mean total charges (median)	38,500 (31,400)	34,400 (28,600)	40,600 (32,300)	<.0001

LOS, Length of stay; *SD,* standard deviation; *CAS,* carotid artery stenting.

Table IX. Frequency of CAS procedures performed in each state stratified by operator type

	New York (n = 2,217)	*Florida (n = 1,784)*	P *value*
Total	55.4%	44.6%	<.0001
VS	45.7%	18.9%	<.0001
IC	37.5%	39.1%	.288
IR	16.8%	42.0%	<.0001

VS, Vascular surgeons; *IC,* interventional cardiologists; *IR,* interventional radiologists; *CAS,* carotid artery stenting.

with CAS for asymptomatic disease. This trend is consistent with previous reports which have evaluated CAS on the national level using the Nationwide In-patient Sample database. McPhee et al reported that for the years 2003-2005, the proportion of CAS procedures being performed in asymptomatic patients was 91-92%.[5,19]

Based on the information available in the State Inpatient Databases studied, it is not possible to comment specifically on why such a large proportion of asymptomatic patients are being treated with CAS, nor on how physicians are being reimbursed for these procedures. The high percentage of asymptomatic patients observed in this study and others may be due to coding errors, leading to misclassification of patients as asymptomatic. However, as hospital reimbursement (based on diagnosis-related group [DRG] coding) is much higher for symptomatic than asymptomatic patients, it is expected that accurate coding in this area would be stressed by hospitals. Participation in industry-sponsored registries (which do reimburse hospitals for CAS in asymptomatic patients) was not captured in the databases used for this study and, therefore, cannot be evaluated.

We found that hospital charges for patients treated by the VS group were significantly lower than for patients treated by the non-VS group. The statistical significance observed may be of limited clinical or practical significance. CAS performed by VS and non-VS was associated with total hospital charges of approximately $35,000 and $41,000, respectively, a fairly small absolute difference in charges. The average length of stay was equivalent for patients treated by both groups. The detailed characteristics of specific costs for the different operator types would best be evaluated by an in-depth cost analysis. The current dataset is limited to overall hospital charge information and, therefore, specific cost factors attributable directly to the operator or related complications are unavailable in this type of study.

On this analysis, it is overwhelmingly clear that the majority of CAS procedures are being performed by operators who are not vascular surgeons. When the NY and FL datasets were analyzed in aggregate, VS performed only 33.7% of all CAS procedures. Moreover, there appears to be substantial regional variation with regards to the proportion of CAS procedures performed by each operator type. In NY, VS performed 45.7% of all CAS procedures, whereas in FL, VS performed only 18.9% of all CAS procedures. This variation and overall reduced market share may have to do with regional referral patterns, different operator thresholds for treatment, and varying appreciation of the evidence in support of CAS that has been published to date. However, vascular surgeons remain the only specialists fully qualified to provide comprehensive treatment of carotid disease, whether this is provided with a stent or with endarterectomy. The lower proportion of stents placed by vascular surgeons may represent more rigorous patient selection, rather than a lack of endovascular technical knowledge and ability. This interpretation is supported by the fact that mortality and stroke rates did not differ between operator types.

Inherent to this study design are several of the limitations that accompany any work utilizing large administrative datasets. The potential for coding errors relating to patient factors, hospital characteristics, or outcomes has previously been described extensively.[23] In the context of this study, the reported stroke rate likely underestimates the true stroke rate as it was based on the presence or absence of a single ICD-9-CM code. Furthermore, it is not possible to determine how many patients were evaluated by an independent neurologist as has become the standard in clinical trials evaluating CAS. Nonetheless, these coding errors are expected to equally affect patients treated by VS and non-VS, and, therefore, are unlikely to introduce significant bias in comparing the outcomes of the different operator types.

Finally, while the primary study outcomes of in-hospital stroke and mortality are important endpoints, they by no means capture all of the elements necessary to judge treat-

ment success. The rigorous patient de-identification process employed by the State Inpatient Databases to protect patient confidentiality precludes the analysis of longitudinal clinical data. Therefore, it was impossible to evaluate other equally important outcomes, such as long-term morbidity and mortality or restenosis.

CONCLUSION

Despite a paucity of evidence in support of performing CAS in asymptomatic patients and current CMS guidelines reimbursing CAS for only high-risk symptomatic patients, both VS and non-VS are treating primarily asymptomatic patients. Perioperative rates of stroke and death are equivalent between VS, IC, and IR. Regional variation is substantial, and despite similar outcomes, fewer than 50% of CAS procedures are performed by VS.

AUTHOR CONTRIBUTIONS

Conception and design: RS, AS
Analysis and interpretation: RS, NC, AS
Data collection: RS, NC, AS
Writing the article: RS, NC, AS
Critical revision of the article: RS, ME, EA, LM, AS
Final approval of the article: RS, NC, ME, EA, LM, AS
Statistical analysis: RS, NC, AS
Obtained funding: AS
Overall responsibility: AS

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INVITED COMMENTARY

William C. Mackey, MD, *Boston, Mass*

This study, based on an administrative database of >4000 carotid stent procedures, has three major findings: (1) 91% of carotid stents are performed in asymptomatic patients, (2) there is significant regional variation in who is performing carotid stents (46% by vascular surgeons in New York and only 19% by vascular surgeons in Florida), and (3) early outcomes across the three specialties performing carotid stenting are equivalent.